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A METHODOLOGY FOR FOSTERING COMMERCIALIZATION OF ELECTRIC AND HYBRID VEHICLE PROPULSION SYSTEMS

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U.S. DEPARTMENT OF ENERGY
Conservation and Solar Energy
Office of Transportation Programs

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Summary

This report documents the rationale behind, and a proposed approach for, application of Government assistance to accelerate the process of moving a new electric vehicle propulsion system product from technology readiness to profitable marketplace acceptance and utilization. The report is primarily targeted at those in industry who will ultimately make the decision of whether or not to become involved in such an activity. It specifically addresses a strategy, applicable incentives, and an implementation process to accomplish this objective. Also included is some background material very familiar to industry. It is provided to inform others with an understanding of the rationale behind the approach discussed.

In preparing this document, numerous references pertaining to the Government's role in fostering the commercialization of attractive technology were reviewed. Additionally, numerous discussions with potential industry participants and Government officials were conducted throughout the formulation of the methodology.

A universally applicable commercialization plan—one which addresses all possible combinations of components, systems, and contractors—could not be formulated because of the large number of possible variations involved. Rather, the basic issues and considerations necessary to implement a successful product commercialization methodology are addressed.

The essence of the methodology evolved is characterized by four factors:

(1) Establish early and continued communication and involvement with appropriate industry teams in all phases of the planning, product definition, and joint-venture execution process.

(2) Establish and maintain a spirit of mutual commitment.

(3) Maximize the use of applicable legislative, financial, and business exclusivity incentives.

(4) Negotiate and execute a cooperative business agreement that shares and gradually shifts the cost, risk, and direction of the commercialization process from the Government to industry participants.

Introduction

The Electric and Hybrid Vehicle (E&HV) program

established by the Energy Research and Development Administration, now the Department of Energy (DOE), in 1975 had as its objective the development of a technology base from which vehicles could be built that demonstrated consumer-acceptable performance, cost, and reliability. The passage of Public Law 94-413 by Congress on September 17, 1976, added new dimensions to DOE's program by broadening the scope of the research and development effort and introducing commercialization aspects such as vehicle demonstrations and financial incentives for industry. The goal of DOE's Electric and Hybrid Vehicle program is to promote and accelerate the commercialization of vehicles that use electricity as the principal source of propulsion energy. Attainment of the goal would result in a significant number of E&HV's finding their way into the marketplace. Successful achievement of such commercialization would ultimately result in significant petroleum savings to the Nation.

To effectively manage the E&HV program, DOE organized the work so that it could delegate responsibility for areas of specific technology (e.g., storage batteries, vehicle design, and propulsion systems) to various Government laboratories with the requisite expertise. A DOE-NASA interagency agreement delegates propulsion system development to the Lewis Research Center. The initial Lewis effort, to assess the state of the art, revealed the immature engineering development status of electric vehicle propulsion systems. The second activity undertaken therefore was to let multiple technology contracts with industry that are focused on applying engineering development to the unique requirements of electric vehicles. This activity is continuing and its intent is to establish a firm technology base that will serve as the foundation for future commercialization efforts.

This report identifies and describes the basic process whereby attractive propulsion system technology will find its way, with Government assistance, into commercial products and thereby become available to E&HV manufacturers. It is not intended to be a road map detailing the step-by-step process whereby each element of hardware under development will achieve commercialization. The specifics of such a detailed plan will of necessity vary depending on the complexity of the hardware and the particular contractor involved. This document does, however, address those aspects of commercialization

strategy common to all elements of hardware under development and discusses a general approach to implementing their commercialization.

Objective

The objective of the effort being reported was to develop an approach whereby early Government assistance, when risks are high, could effectively be used to accelerate the commercialization of a new product. The commercialization process begins at the point where technology readiness has been established and the consideration of a commitment to pursue commercialization is undertaken. It ends when private capital represents the sole source of financing and a buyer-seller exchange occurs at an acceptable price to the buyer and with an acceptable profit to the seller. More specifically, the objective is to stimulate the voluntary involvement of industry in a joint venture with the Government to accelerate the early application and market introduction of commercially viable electric and hybrid vehicle propulsion system and component technology.

Background

DOE's authorization legislation (PL 93-577, amended by PL 95-826) specifically directs it to "...identify opportunities to accelerate the commercial application of new energy technologies..." Federal assistance programs aimed at demonstrating the commercial viability of attractive technology are not new (see Bibliography). For the most part, however, the limited Government experience with such programs does not lend itself directly to the E&HV program, where the objective is to proceed beyond demonstration to application and market introduction. It is true that dramatic examples of technology spinoff into private industry products exist, but the fact remains that the original Government intent in such cases was not to foster the commercialization of an industry product. Commercialization, in the context of this report, should not be confused with technology spinoff or technology demonstration.

A review of the literature did, however, reveal information helpful in establishing an initial point of departure. Taken directly from the Charpie Task Force Report (ref. 1), the following six attributes associated with successful Government-supported demonstrations best summarize general commercialization considerations potentially applicable to the E&HV program:

(1) A technology well in hand

- (2) Cost and risk sharing with industry participants
- (3) Project initiative from industrial sources
- (4) The existence of a strong in-place industrial system for commercialization
- (5) Inclusion of all participants needed to accomplish commercialization in the initial planning and operating stages
- (6) Absence of tight time constraints

After reviewing the available literature it was decided to follow a recommendation that regularly turned up in the background material: namely, involve those whom you expect to participate in the commercialization activity in all phases of the planning and execution process. Listed below are organizations that are either presently active in, or have a potential for future involvement in, the electric and hybrid vehicle business and that were interviewed for the purpose of gaining further insight into the commercialization process. (Also included is the title of the senior management member participating.)

TRW, Inc.—Vice President, Engineering
Automotive Worldwide
Reliance Electric Co.—Manager, Special Motor Products
General Electric—CRD—Manager, Power Electronics Laboratory
Garrett Corp.—Executive Vice President
AiResearch Manufacturing Co.—Vice President and General Manager
Eaton Corp.—Executive Vice President, Corporate Development
General Electric—General Manager, Industrial Control Products Department
Westinghouse Electric Corp.—Manager, Industry Business Development
Gould—Vice President, Research & Development
Westinghouse Semiconductor Division—Group Manager
Heinemann Electric Co.—Vice President, Engineering
Curtiss-Wright—Director, Military & Government Marketing
Prestolite Electric Co.—Vice President, Engineering

At the outset of each discussion it was clearly stated that the purpose of the visit was to obtain specific information about the organization's methodology regarding its commercialization decisions and implementation process. Typical additional questions asked were

- (1) What are your general views regarding electric and hybrid vehicles and the Government's role in their eventual commercialization?
- (2) How would you characterize your company's current and future role in E&HV's?

(3) What incentives are viewed as important when considering the introduction of a new product?

(4) How do you perceive Government contract support used to promote commercialization?

After the initial round of visits a working document outlining an approach to achieving the stated objective was prepared and widely distributed. Eight of the previously visited organizations were revisited for additional discussions and comments regarding the proposed approach. Feedback thus obtained was factored into finalizing the methodology presented in the remaining sections of this report. Summarized in the following paragraphs are the major observations made during the information-gathering cycle that, to varying degrees, influenced the resultant methodology.

The commercialization cycle is a complex process involving many technical and business considerations that come together at various points for management review and approval. Details of the process differ from one organization to another. It is a fluid and iterative process that defies standardization and therefore requires that each case be addressed individually. The cycle is diagrammatically illustrated in figure 1.

Of the two categories, technical factors and business factors, business considerations predominate when pursuing a commercialization venture. (It must be recalled that a prerequisite to go ahead is technology readiness.) Examples of business

factors that influence the commercialization process are

- (1) Corporate posture (current and future plans)
- (2) Market potential
- (3) Investment, timing, and profit
- (4) Predatory competitors
- (5) Current and planned regulations
- (6) Patent and data protection

Examples of technical factors that influence the commercialization process are

- (1) Degree of demonstrated technology readiness
- (2) Realistic goals and milestones
- (3) Adequate funding
- (4) The "not-invented-here" syndrome

Besides these observations, the following additional general considerations influenced the methodology evolved

- (1) Cultivation of industry interest
- (2) Early and continuous Government-industry communication
- (3) Establishment and spotlighting of long-term Government and industry commitments
- (4) Accommodation of a broad range of industry approaches and procedures
- (5) Identification of a product champion and his track record
- (6) Avoidance of downstream surprises
- (7) Maximum use of appropriate Government incentives

It is generally recognized that no "single most likely" scenario exists that will assure the successful commercialization of electric vehicles. What is needed to stimulate a market is a vehicle with a reasonable range and price tag and with performance characteristics close to those of comparable internal combustion engine vehicles. Currently available products preclude the production of such a vehicle. Furthermore, without an identifiable market, industry is reluctant to invest the resources necessary to overcome this product availability barrier. In many respects the situation resembles the "which comes first, the chicken or the egg" analogy. To facilitate a resolution of this apparent stalemate, it is the objective of the methodology evolved to reduce early industry risks, to apply appropriate incentives, and to assist qualified companies to insert themselves into the market.

Strategy

In a free enterprise system, industry is self-controlled and motivated by the drive for increased profits. Any undertaking that seeks to influence the commercialization of a new product must accommodate traditional business practices

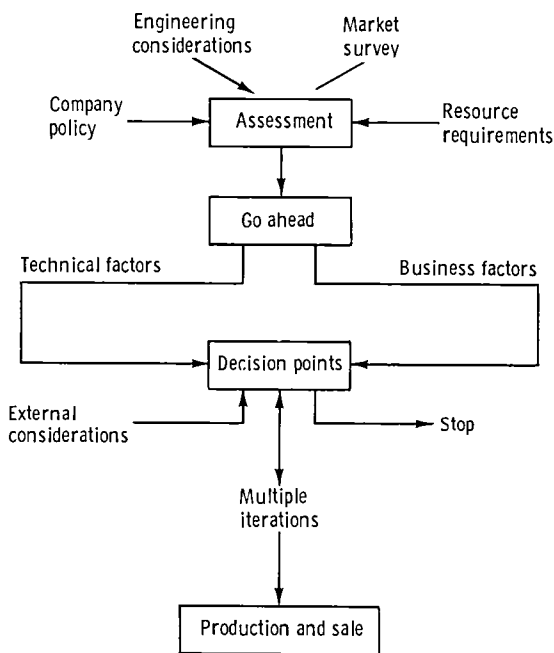


Figure 1. - Commercialization cycle.

employed by companies in the business of manufacturing, selling, and servicing products. In this and the following two sections, a methodology is outlined that describes how such an undertaking might be successfully addressed. It is applicable to the broad range of Government contracting approaches. Formal requests for proposal (RFP), program opportunity notices (PON), invitations for bid (IFB), fixed price contracts, unsolicited proposals, cooperative agreements, and others are accommodated by the methodology presented.

Not all segments of industry are alike. Varying degrees of risk, available capital, and company motivation make it necessary to negotiate and tailor each commercialization activity on a case-by-case basis. For example, a very large corporation may elect to pursue commercialization totally on its own, once technical feasibility has been demonstrated. On the other hand, a smaller company with limited risk capital may welcome Government assistance through the limited product introduction stage. The Government's role must therefore be tailored to assist those organizations in the private sector (1) that will have a significant effect on achieving program goals, (2) that would in the normal course of events become a principal contributor when risks were judged acceptable, and (3) that are receptive to Government assistance.

This commercialization strategy assumes that private industry is, or shortly will be, ready and willing to accept Government support directed

toward accelerating the commercialization process. (Short of a National emergency nothing is envisioned that could force industry to accept what is not in its own best interest.) Success is to be judged on how soon, and how much of, the available technology finds its way into the private consumer market. It is assumed that the future introduction of some number of electric vehicles, as forecasted by many, is acceptable as an attractive market with the only question being, when will the risk become acceptable for voluntary industry involvement. To increase the probability of success, it is critical that industry, particularly those segments that have existing product lines and/or a future vested interest in the markets associated with E&HV hardware, be targeted and become involved as early as possible.

When viewed from this perspective it is reasonable to anticipate some degree of interest on the part of industry when approached by the Government with an offer of assistance. Such assistance can take many forms. Discussed in a later section of this report are various incentives, other than financial, that are considered to be attractive in such an undertaking. One form of financial incentive is the availability of venture capital when risks are high. Even more attractive is the availability of such capital with the agreement that it be paid back only if the venture is commercially successful.

Figure 2 illustrates the strategy embodied in the approach proposed. Illustrated is a typical risk-and-investment-versus-return profile. When risk is high,

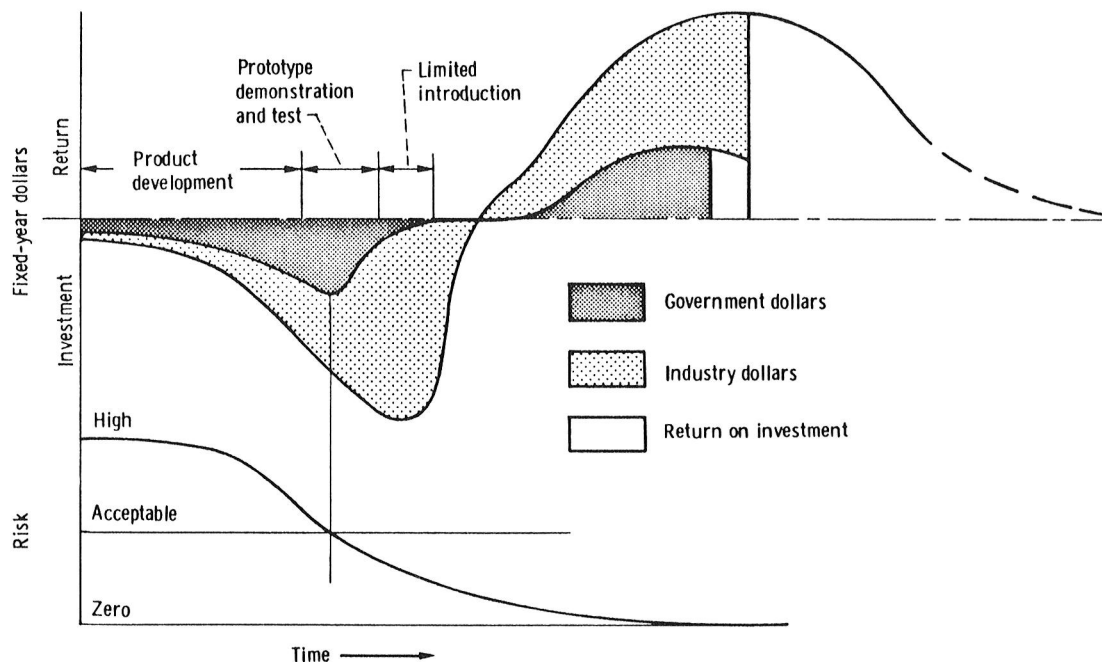


Figure 2. - Typical risk, investment, and return as function of time for a Government-industry joint venture - commercialization cycle.

Government dollars can be levered in such a way as to induce early initiation of the effort. At some time the risk curve crosses the acceptable threshold, and industry dollars become the principal source of support. When the venture becomes profitable, the Government investment is repaid. Assuming for the moment that the joint-venture agreement calls for payback of the principal plus the time-weighted cost of the Government investment (which may or may not be the case), a time is reached when, as far as the industry participant is concerned, involvement of the Government will have had no real effect relative to the industry participant's return on investment. This is so because had the industry participant invested his capital when the risk was high, the actual return on investment, including its cost, associated with that capital would have been the same. In this example the rate of Government dollars was arbitrarily selected so as to have the time when repayment is complete coincide with the time when the industry participants initial investment is fully returned. The net result is to accelerate the time when a product is commercially marketed while at the same time not affecting the industry participant's return on investment. It must be emphasized here that the commercialization cycle assumed is what the industry participant would normally have pursued, on his own, once the risk was deemed to be acceptable. All the normal go-no-go decisions and external factors normally encountered in his pursuit of such an undertaking would apply.

A definitive scenario projecting the future path of electric vehicle commercialization cannot be forecast at this time. From conversations with industry we believe that, when an appreciable market for electric vehicles develops, a composite of the following possibilities will occur:

(1) The largest of the Detroit automobile manufacturers may go it alone, manufacturing essentially all the vehicle components including batteries and propulsion systems in their own facilities.

(2) The other Detroit automobile manufacturers will depend, to a very large degree, on suppliers for components and subsystems. At least until production quantities approach those of current internal combustion engine vehicles, these companies will be content doing what they know best (i.e., packaging, selling, and servicing vehicles).

(3) A variety of smaller specialty vehicle manufacturers will depend on suppliers for all components and subsystems.

The strategy adopted focuses on the second and third of these possibilities. It is the objective of this strategy to put emphasis on potential original equipment manufacturers (OEM's) who will be supplying electric vehicle manufacturers. In this way

the broad range of vehicle manufacturers, from small entrepreneur to most of the Detroit companies, will benefit. Furthermore a large Detroit automobile manufacturer's going it alone may tend to act as an incentive to the other automobile manufacturers and component suppliers and to amplify the advantage of the Government's role in supporting commercialization. Also, the Government's efforts in this regard may tend to provide an incentive to the larger automobile manufacturers and encourage them to sustain their involvement. Finally, it should be pointed out that this commercialization strategy is not to insert the Government into the market, but rather to assist qualified companies to insert themselves into the market.

Many techniques are presently used by the private sector in commercializing a new product. In some cases it is done totally in house by using a corporate R&D-manufacturing division team; in other cases original equipment suppliers team with end product manufacturers; and in still other cases cooperative ventures involving licensing or partnership agreements between organizations are undertaken. In essentially every case, teams that include more than one industry unit are involved. A keystone of this strategy is therefore identifying and cultivating the interest of such teams. It is important to recognize that the process by its very nature requires candid two-way communication of intentions and a mutual agreement on long-term objectives. It will be necessary for the Government to communicate to industry its program plans in such a way as to provide the required confidence level needed by company executives. Visits to targeted industry elements by program and project management personnel explaining first hand the goals and philosophy of the program will go a long way toward formulating a mutually acceptable approach to achieving the objectives. The resulting feedback would enhance understanding and assist in identifying mutually acceptable techniques for accomplishing program goals. A natural result of such a dialogue is expected to be communication between private industry segments wherein they, through their own initiative, will form teams best suited to their own mode of doing business. By communicating program content and applying appropriate business incentives, we anticipate that appropriate private industry teams will be identified and motivated.

A final element of this strategy is to insure involvement of "decisionmaking" management personnel both in industry and in the Government. Within the Government this can be accomplished by requiring concurrence, at the appropriate level, during the commercialization planning stage.

Industry involvement will occur through a requirement to commit, through a negotiated joint-venture contractual agreement, to a long-range product commercialization effort. Because of the nature of the effort, a broad spectrum of innovative business incentives will be considered. It is the intent of this strategy to pursue a businesslike approach to the effort and to clearly spell out all incentives, terms, and conditions up front during the solicitation process. It is considered essential that all anticipated contractual provisions dealing with rights of the contractor and rights of the Government be delineated and factored into the decisionmaking process. By so doing, industry management at the appropriate level will have all the information they need to either accept or decline involvement. Furthermore such an approach minimizes the "downstream surprises" so feared by all parties of a joint-venture agreement.

Recapping, the key elements of the strategy evolved are

- (1) Communication and involvement
- (2) Cultivation of corporate willingness to participate
- (3) Flexibility to accommodate varying industry approaches
- (4) Fostering of a businesslike environment
- (5) Visibility and commitment at the decisionmaking level

In essence the strategy boils down to

- (1) Involving appropriate industry teams early and throughout all phases of the planning, product definition, and joint-venture execution process
- (2) Evolving a cooperative agreement that shares and gradually shifts the cost, risk, and direction of the commercialization process from Government to industry participants.

Incentives

Government use of taxpayer's money is strictly regulated by Federal law. In addition, legislation that establishes each Government organization often contains specific direction in this regard. The E&HV propulsion work being addressed in this report is funded by DOE and conducted by NASA. It is therefore necessary that the rules and regulations of both organizations be observed. Considerable flexibility exists, however, in the Government's ability to stimulate the commercialization of a new product. In deriving the methodology outlined in this report, all incentives available have been considered. "Government incentives," as used herein, refers to any mechanism available to the Government that will encourage industry to voluntarily enter into a joint-

venture agreement with the Government for the purpose of accelerating the commercialization of a new product.

In broad terms the following three categories typify the scope of applicable incentives:

(1) Congressional incentives that foster compatibility between regulations and commercialization (i.e., *legislation*)

(2) Financial incentives that reduce the risk associated with commercialization (i.e., *dollars*)

(3) Business incentives that increase corporate willingness to undertake commercialization in partnership with the Government (i.e., *exclusivity*).

At the program level the DOE is interfacing with Congress to foster legislation that supports the overall goal of electric and hybrid vehicle commercialization. Through various DOE program activities, financial assistance and federally funded contracts are negotiated to further the attainment of specific technical goals. Finally, when the commercialization of a new product is undertaken, business exclusivity incentives must be addressed on a case-by-case basis. Inasmuch as the first two incentives listed are being addressed at the DOE program level, it is the last one on which we will focus in this report. Moreover, it is felt that business exclusivity considerations constitute a major motivating factor in the minds of industry decisionmakers when they contemplate a joint-venture business agreement. The approach outlined below has been discussed with various industry leaders and with NASA and DOE personnel, and for the most part it has been accepted as a good starting point. It must be pointed out, however, that this initial proposal will be fine tuned as more experience is gained during its application as a contractual undertaking.

It is proposed that the Government provide comprehensive information in the solicitation package addressing the use and disposal of industrial and intellectual property rights. Such information will be in the form of selectively created contractual provisions keyed to corporate business incentives and Government interests. Additional provisions will be included to protect the public's interest in the commercialization product item and to treat the Government as a joint-venture capital organization. The areas under consideration include the following:

- (1) Contractor cost sharing
- (2) Government investment
- (3) Inventions and patents
- (4) Data

An important aspect to keep in mind is that inventions made under a DOE-funded contract, by statute, vest in the Government. However, provisions are available to waive commercial rights to the

contractor even before a contract is executed. Each of the four business incentives listed are discussed in detail in the following subsections.

Contractor Cost Sharing

A minimum amount of cost sharing by the contractor and/or a percentage of sales in foreign countries until the interest cost to the Government on actual dollars invested is paid back will be required to solidify the contractor's commitment. It is anticipated that this minimum amount will be established in the solicitation and may vary with the program being undertaken and the associated program risks. There may be instances where a contractor proposes to contribute a higher percentage than that established in the solicitation. These requests will certainly be accommodated. The percentage of cost sharing may vary in programs where the phase type of procurement is involved and probably will increase as the risk to the contractor of achieving a commercially profitable position decreases.

Cost sharing will be an integral part of a decision to waive invention rights to the contractor and thus will be construed as a partial basis for waiver of any inventions conceived or first reduced to practice in the course of performing work under the contract. Additionally, cost sharing by the contractor will be a consideration in the decision to provide some contract-generated data exclusivity rights to the contractor.

Government Investment

Inasmuch as a commercialization program places the Government in the position of a venture capital corporation, payback of dollars invested by the Government is deemed appropriate. Payback is envisioned as occurring through the use of two approaches and, it should be emphasized, only if the program is commercially successful. First, the actual dollar amount invested by the Government will be paid back on the basis of a negotiated amount per item sold commercially in the United States and/or a percentage of U.S. sales. Reconsideration of the payback provision in the event this additional sum of money adversely affects commercial sales volume will be provided for in the contract. Second, it is anticipated the Government will receive a negotiated percentage of royalties obtained by the contractor on any foreign contract-related technology agreements and/or a percentage of sales in foreign countries. It is recognized that some corporations do not enter into foreign technology agreements but rely instead entirely on sales in foreign countries for foreign

profits. Thus, by providing maximum Government flexibility in this area, a corporation's particular format of foreign activities can be accommodated. This approach results in the domestic users who will benefit from the effort paying back the initial investment and foreign entities paying back the cost of the investment. The duration of repayment will be left open for negotiation and could be terminated, for example, when a payback based on cost (at prevailing interest rates) of the Government's dollar share of the contract is achieved.

As with cost sharing by the contractor, these payback provisions will be an integral part of the Government's decision to grant the contractor a waiver of any contract inventions and to provide some contractor exclusivity rights in contract-generated data. As will be discussed subsequently, contract-generated invention rights and contract-generated data rights can be a very important part of any foreign licensing technology package.

This approach appears to be favorably viewed by private industry because heretofore many cost recoupment provisions contained in Government contracts were subjective in nature and required an exorbitant amount of administration time on the part of the Government and the contractor for effective monitoring.

Inventions and Patents

An important inducement to private industry is the opportunity to secure commercial rights to inventions made in the course of performing work under a contract funded by the Government. These rights are deemed essential to permit the development of a licensing package. Although a contractor may have a basic patent, its value can be enormously enhanced by also having control of improvement patents. Furthermore, by a contractor securing rights to inventions and handling the patent prosecution, the claim structure can be melded into its basic patent claim structure and commercial plans.

To accommodate a contractor's interest in contract-generated inventions, minimum requirements will be established in a solicitation which, if met, would provide a high probability of a waiver being granted of domestic and foreign commercial rights to inventions made under the contract. Additionally, such a determination would be made before execution of a contract so that the contractor would know up front the disposition of this matter. Basically, cost sharing of at least that percentage established in the solicitation and a full payback of Government dollars invested and the cost of these dollars are the prime factors that will be considered in making this determination.

As with the data considerations discussed below the public's interest will be protected by providing in the contract for Government march-in rights (non royalty bearing to the contractor) to contract-originated patents. Similarly, Government march-in rights (royalty bearing to the contractor) to a contractor's background patent portfolio, if necessary to practice the contract product item, will also be provided for in the contract.

Data

Provisions protecting the contractor's rights to background data (i.e., trade secrets) will be included in the contract. Such data will not be required to be delivered to the Government but will be made available (at the contractor's situs) to Government personnel to review and inspect as necessary to understand technological developments derived under the contract. Further, these provisions will provide for only selected contract-generated data (i.e., form, fit, and function) to be immediately delivered to the Government with unlimited rights during the course of contract performance. Delivery of such selected data will adequately enable the Government to account to the public and to report timely results of its funding activity. The contractor will be permitted to treat the remaining contract-generated data as a trade secret for a negotiated time period. As with the contractor's background data, all withheld contract-generated data will be available for review and inspection by Government personnel at the contractor's situs.

In this rather unique type of undertaking, a venture partnership arrangement between Government and industry, it is not deemed necessary to require delivery of all data generated during the course of the contract performance. Although data may be technically valuable, their value as part of a foreign technology licensing package becomes minimal when such data are available to the world. Thus, by permitting a contractor to maintain principal domestic and foreign control of contract-generated data other than that of a form, fit, and function nature, worthwhile rights as a part of a foreign technology business package may be created therein. When payback of the Government's investment costs is completed or a negotiated time period has expired, it is proposed that all nondelivered contract-generated data would be placed in the public domain. The timing of such public disclosure is considered to be acceptable to the contractor and serves to fulfill the Government's objective of full disclosure of information generated under the contract.

The public's interest will be preserved by providing in the contract for march-in rights (non royalty bearing to the contractor) to all contract-generated data (other than form, fit, and function) if the contractor cannot meet commercial demand or if the contractor drops the venture. Concomitantly, march-in rights (royalty bearing to the contractor) to the contractor's background data will be provided for in the contract only if such data are essential for practicing contract-item-related patents if the contractor cannot meet commercial demand or if the contractor dropped the venture.

Incentives—Concluding Remarks

In concluding this section on incentives several points are worthy of emphasis. The Government has the unilateral power to make most of the incentives discussed available and thus to induce private industry to become involved in a commercialization venture arrangement. By including up front, in a solicitation, special provisions related to cost sharing, reimbursement of Government investment, inventions and patents, and data, the contractor is afforded the opportunity to make intelligent decisions regarding a commitment to such a program. Inasmuch as no downstream surprises are to be anticipated, the contractor will be in an excellent position to plan ahead for the effective use of his personnel and financial resources. The approach as presented appears to balance the equities of the contractor and the public and provides important incentives to encourage participation by private industry.

Implementation Process

The methodology that has been discussed throughout this report forms the basis for the generalized implementation process diagrammed in figure 3 and discussed in more detail in this section.

It should be noted that each product commercialization effort will be different and, depending on the form of the solicitation, some of the steps discussed here may not be required. The main steps in the implementation process are as follows:

- (1) Periodic industry briefings: An industry briefing on Lewis E&HV Propulsion System Project Office activities and interests would be conducted periodically. The briefing would be publicized broadly in advance. Its purpose and content would be clearly outlined in the Commerce Business Daily (CBD), in various industry publications, and through

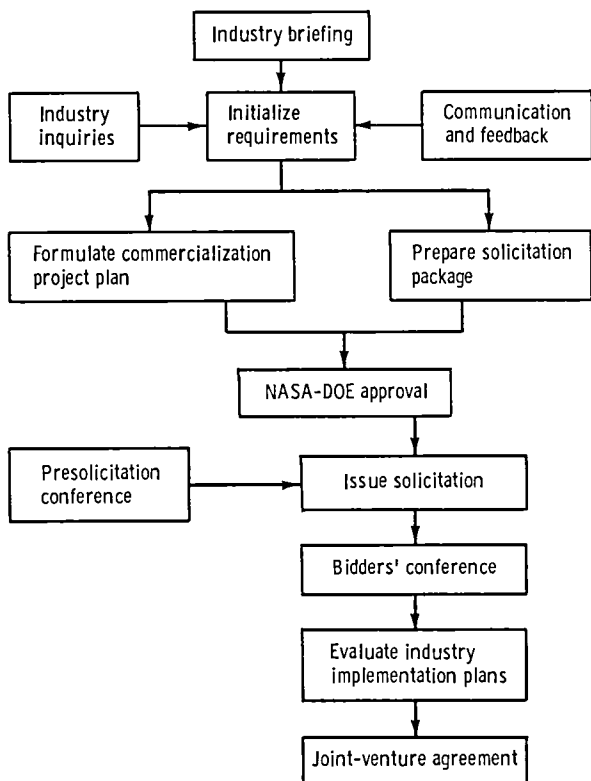


Figure 3. - Block diagram of implementation process.

the use of general mailing lists. At the briefing the current status, results, problems, interests, concerns, and direction of the overall activity would be presented. Overall goals, philosophy, milestones, and schedules would be addressed in very general terms. In such an industry briefing the general approach, groundrules, incentives, and procedures associated with how the Government does business (i.e., cost plus fixed fee, fixed price, and cost sharing) and the regulations associated with unsolicited proposals would be outlined.

(2) Periodic inquiries of specific project interests: As a need is identified, an industry-interest-sought inquiry article would be published in the CBD and in various industry publications and distributed to an interested-party mailing list. Such an article would refer to the prior industry briefing and specifically address one topic of current interest to the project. All standard operating procedures and regulations for such an inquiry would be followed.

(3) Initial identification of need and requirements: In formulating a product commercialization effort, the Government must consider many factors. Several of the more significant considerations are the availability and limitations of existing products; the state of the art of on-going technology; realistic projections of cost-benefit and consumer acceptance

factors; interfaces with and effects on other efforts; and program considerations of schedules and available funding.

(4) Communication and industry feedback: During the initial formulation process it is essential to involve industry and to relate to industry considerations. Their knowledge and experience relative to how commercialization of a particular product could best be achieved is indispensable. Appropriate levels of corporate executives must be reached and interfaced with equivalent program and project management personnel. The following topics should be addressed in this stage: Is there sufficient interest? Is the timing right? Is the technology in hand? What are realistic goals, schedules, and costs? What are the appropriate Government incentives to use? What is the best approach or process to pursue?

(5) Government formulation of a commercialization project plan: The results of steps 3 and 4 should be prudently considered and factored into a long-range commercialization project plan (CPP). Specific delineation of the method of implementation should not be addressed in this step. To be included in the CPP are such items as schedules, interfaces with other efforts such as vehicle demonstrations, Government incentives to be used, major milestones, philosophy relative to possible multiple awards, and funding and cost-sharing strategy. The detailed approach to implementing the proposed effort is best left to the bidder so that it is compatible with his standard practice.

(6) Review and approval of the commercialization project plan by DOE: Throughout the preparation of the plan, program and project communication will be maintained. Before proceeding with step 8, approval of the CPP at an appropriate DOE management level, signifying Government commitment to the effort, is required. The plan thus approved will be subject to periodic review and revision as conditions warrant.

(7) Preparation of a statement of work and solicitation package: Incorporated in the solicitation package will be the CPP (except for funding estimates). Also conspicuously included will be all commercialization considerations such as special clauses requiring potential bidders to be existing manufacturers in the particular field involved, applicable incentives, and cost sharing. As part of his proposal the bidder will be required to prepare a long-range product commercialization implementation plan (PCIP) that further expands the Government-prepared plan into specific phases, tasks, and work elements. In his plan the bidder will estimate the cost of the whole job, the cost of each phase, the proposed cost-sharing arrangement of each phase, the costs by task of the first phase,

overall schedules and milestones of the whole job, and detailed schedules and milestones of the first phase. Also in his proposal the bidder will identify and describe the organizational, team, and subcontractor arrangements proposed for each phase of the effort. Clearly stipulated will be the requirement to update the PCIP. In preparing the solicitation package every effort will be made to be specific, but not restrictive, so that a spectrum of approaches can be accommodated.

(8) A presolicitation conference: Before the solicitation package is finalized and issued, interested parties will be given an opportunity to comment on the proposed effort. One of the prime objectives of the conference will be clarification of how the proposed effort fits into the overall DOE E&HV project. The second objective will be to inform potential bidders of what the package contains, its objective, etc., and what will be required of the bidders in order to be responsive. Appropriate feedback will be incorporated into the final version of the solicitation package.

(9) Issuance of the solicitation package: Ample time will be allocated for preparation of proposals. If the proposed process thus far has been successfully executed, potential bidders will be ready for and not surprised by the solicitation.

(10) A bidders conference: Bidders' questions regarding the solicitation will be answered strictly according to the rules and regulations governing such a conference.

(11) Proposal evaluation, site visits, and selection: Proposals will be evaluated by using standard NASA procedures described in NASA Procurement Regulations Directive 70-15 as currently revised. As part of the evaluation process, companies in the competitive range may be visited, in part to ascertain the company management attitude toward the "commercialization objective." Selection will be based on criteria clearly described in the "Source Evaluation Procedure" section of the solicitation.

(12) Execution and management of the joint-venture agreement: As each phase progresses, a strategy will be maintained that requires that the degree of Government cost sharing and project direction continually decreases while industry's share of the cost and degree of direction increases. At a mutually agreed to point in the program the effort will be assumed to be completed. Industry presumably will proceed to manufacture and market the new product.

industry leaders and about two dozen Government management personnel were contacted for input and guidance. General conclusions gleaned from the activity are summarized below:

1. The methodology is viewed by industry as refreshing and innovative.
2. From the Government's point of view it appears workable.
3. Industry-perceived barriers can be overcome.
4. Many intangible benefits result from candid dialogue.
5. It is essential to delineate all terms and conditions up front.
6. Industry and Government "decisionmakers" must be reached early in the process.

The essence of the methodology evolved is characterized by the four factors presented in figure 4.

The Government's commercialization project plan has as its purpose (1) to form the basis for program coordination, approval, and commitment; (2) to prescribe all proposed terms, conditions, and incentives; and (3) to verify the state of technology readiness. The content of the plan prepared by the Government with relevant industry input outlines the objective, general approach, schedules and major milestones and estimates the planned cost and cost-share targets. It is the basis for a Government commitment, and its approval is a justification for industry solicitation.

Aggressive pursuit of appropriate incentives, judiciously applied in a businesslike fashion, is necessary and must be incorporated into the solicitation so as to encourage industry participation.

The industry-prepared product commercialization implementation plan has as its purpose (1) to form the basis for the bidder's response to the solicitation, (2) to provide a commitment to commercialization, and (3) to define an approach structured around the

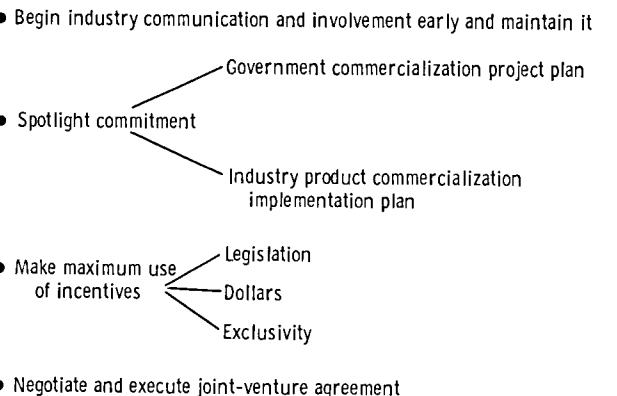


Figure 4. - Essence of methodology.

Concluding Remarks

The effort reported on herein spanned a period of about 16 months. During that time roughly 75

bidder's particular way of doing business. The content of the plan details the approach, execution process, go-no-go criterion and decision points, and the cost breakdown (including cost-sharing percentages); may be modified during negotiations; and becomes the basis of the joint-venture contract.

It must be emphasized that the methodology outlined herein has been formulated with the unique requirements of the DOE Electric and Hybrid Vehicle program in mind. Its applicability to other Government commercialization activities is obvious. However, as stressed throughout this report, each case has unique requirements and must be examined separately.

In conclusion, it is the conviction of the authors that use of this method early in the commercialization cycle, when risks are high, will favorably influence industry decisionmakers to join with the Government in achieving the objectives of the Electric and Hybrid Vehicle program.

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